AN EOCENE PRIMATE FROM CALIFORNIA

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Introduction.—Recognition of a primate in the mammalian assemblage now being recorded from one of the faunal stages of the Sespe, north of the Simi Valley, California, comes with startling abruptness, yet is not wholly unexpected. No fewer than five fragments of jaws, probably representing as many individuals, have been found recently. The sudden appearance of this material in the collections of fossil mammalian remains obtained at Locality 150 Calif. Inst. Tech. Vert. Pale. commands attention when it is stated that excavations at this site have been in progress more or less continuously during the past two years.

Relationship of the new type appears to be particularly close with that division of the tarsiid lemurs (Anaptomorphidae) which includes the Eocene genera *Omomys*, *Hemiacodon* and *Euryacodon*. Lending interest to the discovery is the fact that this form represents the latest primate to be recorded from the North American Tertiary. Moreover, the occurrence marks another outpost for a group of mammals whose presence on this continent during the Eocene has been identified heretofore with intermontane basins of the Cordilleran region.

Chumashius balchi, n. gen. and n. sp.

Type Specimen.—Fragmentary left ramus of mandible with $P\bar{3} - M\bar{3}$ and alveoli for $P\bar{2}$ and C, No. 1391 C. I. T. Vert. Pale., plate 1, figures 1, 1*a*.

Paratypes.—An incomplete left mandibular ramus, No. 1392, plate 1, figures 3, 3*a* and 3*b*, and a fragment of palate with $M\underline{2}$ and $M\underline{3}$, No. 1394, plate 1, figure 4.

Referred Specimens.—Two incomplete mandibular rami with portions of the premolar-molar series, No. 1393, plate 1, figures 2 and 2*a*, and No. 1390.

Locality.—Sespe Upper Eocene, north of Simi Valley, Ventura County, California; Locality 150 C. I. T. Vert. Pale.

Generic and Specific Characters.—Dentition $\bar{2}?, \bar{1}, \bar{3}, \bar{3}$. $P\bar{4}$ without distinct metaconid. Paraconid median and distinct in $M\bar{1}$, more reduced in $M\bar{2}$, vestigial in $M\bar{3}$. $M\bar{3}$ reduced in size and with inner and posterior cusps of heel subdued or absent. Enamel smooth. $M\underline{2}$ and $M\underline{3}$ with well developed cingula, except on external sides. Intermediate cuspules small and faintly indicated. $M\underline{3}$ more reduced in transverse diameter than in *Euryacodon*. No indication of antero-internal cuspules on $M\underline{2}$ and $M\underline{3}$ as in *Euryacodon*. Referred specimens larger than type and paratype and

approximate in size the species *Omomys carteri*. The species is named for Mr. Allan C. Balch.

Description.—Although the maxillary fragment bearing the two upper molars cannot be directly associated with any one of the jaws, the presence of probably four individuals of this primate at locality 150, as based upon the lower jaw material, makes it reasonable to assume that all of the specimens pertain to the same type of creature. Moreover, some of the characters exhibited by the upper teeth are to be correlated with those displayed by the lower posterior molars. The four lower jaws from locality 150 show some variation in size (compare for example Figs. 1, 1*a* and 2, 2*a*). Judging from the state of wear of the teeth in these specimens, the difference in size cannot be accounted for on the basis of age. With exception of the larger size of $M\bar{3}$, relative to the anterior molars, in No. 1393, no important structural features appear to distinguish this specimen from the type. On the other hand, the differences in size may reflect a difference in sex. In this connection it may be mentioned that the canine alveolus in the referred ramus, No. 1390, suggests the presence of a tooth of comparatively large size.

In *Chumashius* the mandibular rami were not fused at the symphysis. The horizontal ramus, as seen in No. 1391, is straight and sturdy. Two mental foramina are present, the posterior situated beneath $P\bar{3}$ and the anterior below and slightly in front of the alveolus for $P\bar{2}$. The anterior base of the ascending portion of the ramus is broad but thins rapidly in its upward course. The anterior portion of the masseteric area is best shown in the paratype, No. 1392, where it is seen to be quite shallow. The posterior dental foramen can be discerned on the inner side of the ascending portion of the ramus (Fig. 3*b*, *p.d.f.*). The position of this opening is closer to the lower border than to the upper anterior border. Fortunately the angle is preserved in this specimen. A low, subdued crest is present on the inner surface of the angle. The process extends downward and backward and is hook-like in shape. The latter character in *Chumashius balchi* is totally unlike that in *Tarsius* and somewhat resembles that in modern lemurs other than *Tarsius* as well as in *Notharctus*.

The present comparisons of the dentition in the Sespe specimens may be found somewhat limited in scope, in view of the fact that the available comparative materials of primates include only a cranium and mandible of *Tarsius spectrum* borrowed from the U. S. National Museum and the type specimen of *Omomys carteri* Leidy kindly loaned to me by the Academy of Natural Sciences of Philadelphia. However, published descriptions and illustrations of Eocene primates, particularly those by Wortman,[1] Matthew[2] and by Gregory[3] permit an extension of the observations made on the forms from the Simi locality.

Although the lower dentition preserved in the materials from the Simi

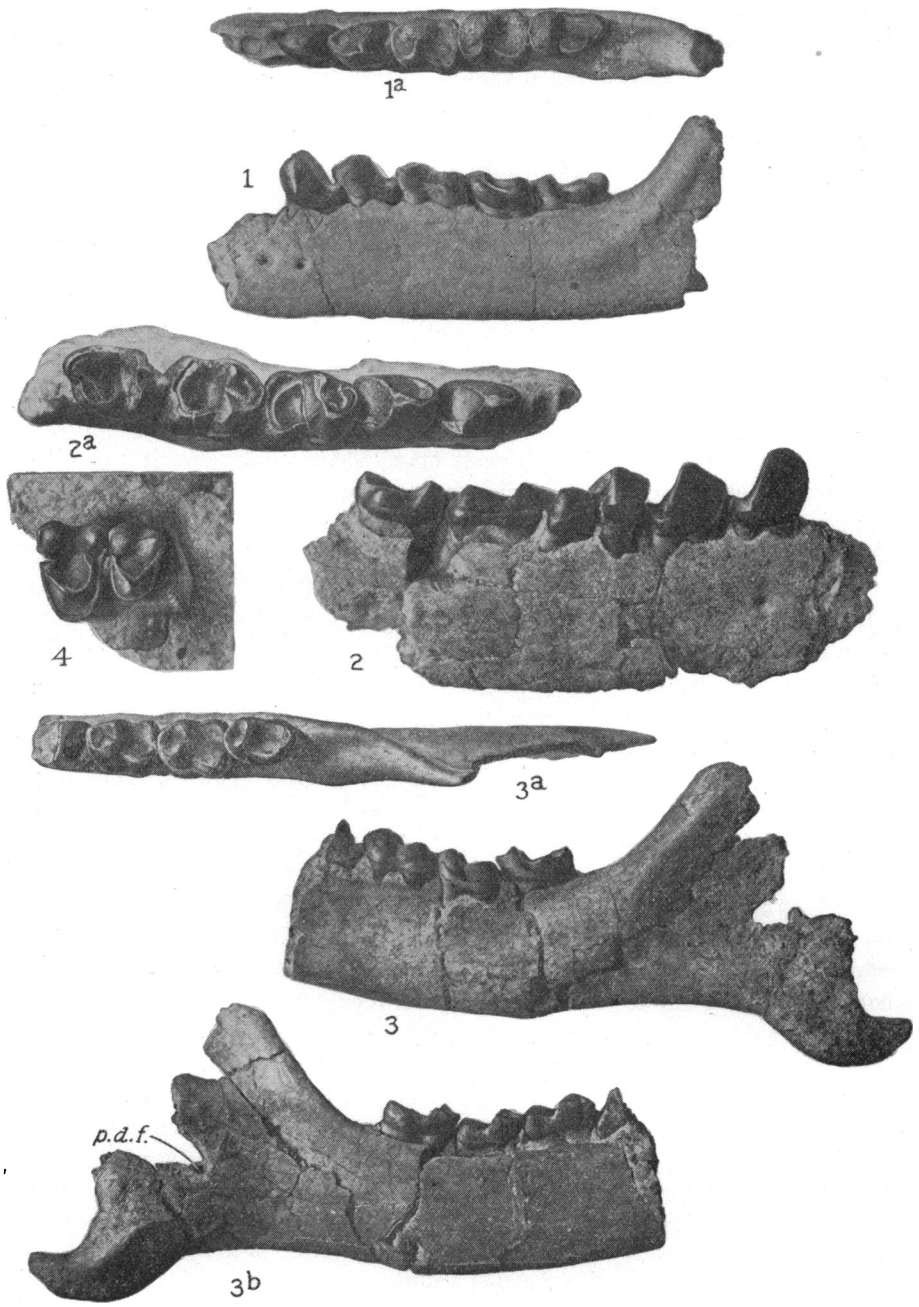

PLATE 1. (Description on opposite page.)

gives a representation of $P\bar{3} - M\bar{3}$, three of the four jaws furnish evidence of value in determining the lower dental formula. In the type specimen, No. 1391, as well as in No. 1393, two distinct alveoli are to be seen anterior to $P\bar{3}$. These are presumably for the canine and premolar 2. In both jaws the alveolus for the canine is larger than that for $P\bar{2}$. Similar characters are to be noted in No. 1390. Fortunately, in this specimen more of the anterior end of the jaw is preserved although the tip is not present. Portions of the alveolar walls of at least two incisors can be discerned. Thus, in number of lower teeth *Chumashius* differs from the Eocene genera *Anaptomorphus* and *Tetonius* and resembles *Omomys* and *Hemiacodon*.

$P\bar{3}$ resembles the comparable tooth in *Omomys* in shape of base and height of crown. A rudimentary posterior ledge is present and a metaconid is absent.

$P\bar{4}$ likewise resembles the comparable tooth in *Omomys* in shape of base and height of crown. It differs, however, from the fourth premolar in *O. carteri* in absence of a distinct metaconid. In the three specimens from the Simi where the crown of this tooth is preserved either entirely or in part, the development of the metaconid is seen to be subject to some variation. In both the type and No. 1393 a slight bulging of the postero-internal border of the protoconid is all that denotes the presence of a metaconid.

Greater definition of this cusp is seen in No. 1390, although in this specimen also the metaconid is not so distinctly formed as in the type of *O. carteri*. In tendency to reduce the metaconid the Sespe species appears to be more advanced than *O. carteri*. A narrow ledge extending the full width transversely forms the posterior base of the tooth. Toward the outer side the surface of this base as well as that on the lower flank of the protoconid immediately adjacent are worn, due to occlusion with an upper tooth. Both $P\bar{3}$ and $P\bar{4}$ are shorter and wider than the comparable teeth in *O. carteri*.

$M\bar{1}$ and $M\bar{2}$ are likewise shorter and wider than in the latter species. In at least one specimen, No. 1390, the basins of the talonids of the anterior molars appear to be shallower than those of the Bridger species. The anterior molars show the characteristic widening of the talonid region seen in *Omomys*. In $M\bar{1}$ (see figure of paratype, plate 1, Fig. 3*a*) the paraconid is well developed, and the trigonid region resembles that in the genotype of *Omomys*.

DESCRIPTION OF PLATE 1

Chumashius balchi, n. gen. and n. sp.

Figures 1 and 1*a*, type specimen, No. 1391, left ramus with $P\bar{3}$–$M\bar{3}$ and alveoli for C and $P\bar{2}$, lateral and superior views; figures 2 and 2*a*, referred specimen, No. 1393, lateral and superior views; figures 3, 3*a* and 3*b*, paratype, No. 1392, lateral, superior and inner views, respectively: figure 4, paratype, No. 1394, maxillary fragment with $M\underline{2}$ and $M\underline{3}$, occlusal view. All figures × 4.

California Institute of Technology Collection. Sespe Upper Eocene, California.

In the second lower molar the paraconid is not so well defined as in $M\bar{1}$ and is also more reduced. The paraconid is even more reduced or is vestigial in $M\bar{3}$. Thus in the lower molars the trigonid region becomes progressively smaller and the greater fore and aft narrowing of this area, as one proceeds from the first to the last tooth, is particularly striking (Figs. 1*a*, 2*a* and 3*a*). A similar progressive reduction of the paraconid in the molars occurs in *Hemiacodon*, according to Matthew. In the characters noted *Chumashius balchi* differs from *Omomys carteri* and is more advanced than this type. A closer approach to our form appears to be made by specimens described by Wortman and referred to the species *Euryacodon lepidus*.

$M\bar{3}$ in the Simi form is distinctly narrower transversely than either $M\bar{2}$ or $M\bar{1}$ and there is likewise less widening of the talonid region. No inner cusp is present on the talonid and the inner rim swings backward to form the posterior rim of the posterior lobe. The posterior rim is worn in No. 1393 and in No. 1391 and there is no clear indication of a hypoconulid. In No. 1392, however, the faintly scalloped inner rim merges posteriorly with a worn surface marking the presence of a hypoconulid. Wortman has pointed out that in the third lower molar of the jaw referred to *Euryacodon lepidus* the crown is narrower than in *Omomys* and differs also from that in the latter in absence of distinct pointed cusps in the talonid region.

The discrepancy in size between $M\bar{3}$ and the anterior molars is not so evident in the referred specimen, No. 1393, as in the type and paratype of *C. balchi*. Unfortunately, the last molar is lacking in the second referred specimen, No. 1390.

In the second upper molar of the paratype, No. 1394, a well defined cingulum is present on the anterior and posterior sides of the tooth and also where it is preserved along the inner side. A portion of the cingulum on the inner side has been broken away, but sufficient of it remains to indicate that an antero-internal cuspule, such as characterizes *Euryacodon*, was not present. The intermediate cuspules are low and not very distinct.

$M\underline{3}$ is considerably more reduced in transverse diameter than the comparable tooth in *Omomys* or in *Euryacodon*. The tooth is broader internally than that of *E. lepidus*. The anterior intermediate cuspule is vestigial. The enamel surfaces of both upper teeth are smooth.

Relationships.—In two primitive characters, namely, the sutural separation of the mandibular rami at the symphysis and the hook-like angular process, *Chumashius* differs from the modern tarsier. These characters have been noted by Gregory[4] as also distinguishing the earlier species of *Notharctus*. In contrast to the primitive features and small size of the Simi form, *Chumashius* is more advanced than *Tarsius* in tendency to reduce the metaconid in $P\bar{4}$, reduction in size of paraconid in the posterior lower molars with vestigial character of this cusp in $M\bar{3}$, and in reduction in size of the

last upper and lower molars. *Chumashius balchi* cannot, therefore, be regarded as occurring in the direct line of development leading upward to the Recent tarsier.

In lower dental formula *Chumashius* exhibits a closer relationship to *Omomys* and *Hemiacodon* than to *Anaptomorphus* and *Tetonius*. The character of the lower posterior premolars in *Uintanius* suffice to remove this Bridger genus from any close relationship with the Simi form. In addition to the presence of a comparable number of lower teeth the structural details of the dentition, in so far as these are known, point also to a kinship between *Chumashius* and that division of the Anaptomorphidae including *Omomys* and *Hemiacodon*. The characters of the Simi genus suggest a development from those of an antecedent form like *Omomys* or *Hemiacodon*. Possibly *Euryacodon* is also situated close to the stem form from which *Chumashius* has evolved. No previously described tarsiid from the North American Eocene has been found in association with a fauna as advanced as that occurring with *Chumashius balchi* at Locality 150 in the Sespe deposits of the Simi Valley region, California.[5]

[1] Wortman, J. L., *Amer. Jour. Sci.*, **15–17** (1903–1904).

[2] Matthew, W. D., *Bull. Amer. Mus. Nat. Hist.*, **34**, 445–465 (1915).

[3] Gregory, W. K., *Mem. Amer. Mus.*, n. s., **3**, pt. 2 (1920).

[4] Gregory, W. K., *Bull. Geol. Soc. Amer.*, **26**, 419–446 (1915).

[5] Stock, C., *Proc. Nat. Acad. Sci.*, **18**, 518–523 (1932); **19**, 434–440, 481–486, 762–767 (1933).

NOTE ON POLYNOMIAL INTERPOLATION TO ANALYTIC FUNCTIONS

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Let C be a Jordan curve of the z-plane, and let the function $w = \phi(z)$ map the exterior of C onto the exterior of the unit circle $|w| = 1$ so that the points at infinity correspond to each other. Let C_ρ denote generically the curve $|\phi(z)| = \rho > 1$ exterior to C.

If the function $f(z)$ is single-valued and analytic interior to C_ρ but has a singularity on C_ρ, then any sequence of polynomials $p_n(z)$ of respective degrees n is said to converge to $f(z)$ on C with the *greatest geometric degree of convergence* provided for every $R < \rho$ there exists M dependent on R but not on n or z such that we have

$$|f(z) - p_n(z)| \leqq \frac{M}{R^n}, \; z \text{ on } C. \tag{1}$$